L0 Review Draft Report

Committee Members
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Charge
The D0 RunIIb project would like to evaluate the readiness for production of the Layer 0 silicon detector modules. This task involves the assembly of sensors, analog cables, pitch adapters, and hybrids into a readout module and associated testing. We would like the committee to consider:
- The overall plan for production, spares, time scale and manpower needed,
- The plan for quality assurance and testing of modules,
- Documentation and associated travelers and databases,
- Results from prototype devices.

Executive Summary
The committee finds that the overall production plan is reasonable well considered. Two areas of concern are the quality of the pitch adapters and the quantity of hybrids that meet the mechanical specifications. The production pitch adapters have not yet been fully inspected, but it appears that a sufficient supply of adequate quality is available for the production. A new source is being developed, but only one type of pitch adapter is being ordered from this source. We encourage the project to order both types as they samples are of better quality than the part in hand. The committee was informed that the out-of-spec hybrids are useable, but that tooling modifications would be required. It appears to us that these parts will become part of the production and recommend that dedicated tooling be made now to handle them, rather than making on-the-fly fixes to the existing tooling in the time-critical last weeks of the production cycle.
With regard to spares, schedule and manpower we find that the intent of fabricating eight modules of each type may fall short based on the prototype parts where 20% of the parts are below the quality to even be considered for installation. This implies both that the out-of-spec hybrids will likely become part of the production and that the ramp-up in production rate capability is a wise investment. We were informed that there is no plan in place to train additional staff for assembly and feel that this will be necessary to reach the goal of 8 modules per week (current staff could probably get to 6 per week). We recommend that additional staff be trained immediately on additional "preproduction" modules. These would also be used for verification of the additional tooling being made for production that was not available in the past. We do not feel that production proper should begin until the final tooling and staff training is completed, although we recognize that any preproduction modules that are of high quality can and should be considered production parts. In terms of staff we recommend an additional mechanical technician (Tim Griffin has been identified) and wire bonder (probably Michelle Jonas) be trained. This will also provide coverage in the case of illness, vacation and the like. In particular it is critical that Tim be fully trained in all assembly steps.
The QA plan was obviously lifted from the full Run IIb detector and in some areas does not appear to be the correct model for this scale of project. We believe that the correct model would include extensive testing (electrical, burn-in, thermal cycling, installation

on prototype mechanical structure and system tests) of the preproduction and early production parts, followed by "standard" QA in production, with one module per week tested more extensively. The concept of extensive testing of 10% of the modules simply does not apply well with these small quantities. The QA plan itself remains rather vague as it was carried over from the Run IIb plan that was not completely understood when it was written. We would expect that a more thoughtful plan would be in place in the wake of the preproduction fabrication and testing experience from the past year. The committee also stresses the importance of investigating any systematic affects, no matter how small, as they may be amplified as the system is built and in the final installed environment. Getting a large set of preproduction modules mounted on a support structure as quickly as possible is of paramount importance for identifying electrical issues that may need to be addressed at the module level.
The preproduction modules generally are of good quality. However, there are clearly two very bad modules (118 and 121) and a third (304) that would not meet the specifications provided to us to be included in the 64 "production" modules. In addition to these obvious defects, there are some systematic effects observed in the test results that are not yet understood and which could grow to be problematic when many modules are coupled on the support structure and operated at D0. Again, getting a large set of preproduction modules mounted on a support structure as quickly as possible to study these features should be a number one priority.

In summary, the main issue with starting production at this time is that the final tooling is not yet available and tested with preproduction assemblies, nor has adequate manpower been trained for the peak production rate. It is evident that the project plan does not include allowance for these activities, which are essential to be ready for production. Other issues such as the systematic "features" in the module data are areas that the project should give high priority to, but these should not stand in the way of the start of production modules assembly and testing.

Findings and Observations

- All production components are in hand with ~100% spares in all cases. This appears to be a sufficient set of spare components to complete module production.
- The prototype hybrids include a large number (49) that were incorrectly diced. There are 70 hybrids that meet all specifications. The module production calls for production of 64 modules, leaving very few "process spares" to allow for losses in hybrid production, testing and burn-in. The committee was informed that the out-of-tolerance hybrids could be used, but that tooling adjustments would need to be made to accommodate them.
- Hybrids will be stuffed (including SVX chip bonding) at NXGen in California. D0 collaborators at Fresno are the point of contact. NXGen have stuffed three batches of hybrids (5, 5, 36). The first batch had errors (incorrect resistor value). D0 personnel have been present at NXGen during these runs. Yield appears to be near 100%. The production plan calls for one more run at NXGen to stuff all remaining hybrids.

- Ten pre-production modules have been assembled. Five of these ten modules use all final production parts and roughly ½ of the production tooling.
- Pitch adapter quality has been an issue. D0 has in hand a sufficient number of parts for which initial tests indicate suitable quality, but full inspection is not yet done. A new vendor (ATT) has provided samples of very high quality and a requisition is in FNAL purchasing for 50 of one of the two required pitch adapter types. Delivery is 4 weeks ARO.
- The modules do not yet have the required wire bond protection (bumpers or encapsulation). These are an integral part of the modules and could have an impact on the electrical and mechanical certification process.
- The stated plan is to build 8 of each module type and then select the best 6 for the detector. No specifications were available for determining whether a module is acceptable for installation, i.e. to qualify as one of the 8 modules. One or two of the 10 prototype modules would likely fail such criteria and would require additional module production. Without these specifications it is difficult to extrapolate the prototyping effort to the production. {Specifications have since been supplied to the committee}.
- The production plan provided to the committee indicates the start of production in CY04 with two weeks of production at 4 modules per week prior to the holiday break at the end of the year. Production then restarts at the beginning of CY05 at 4 modules per week for 3 weeks, then a week at 6/week and finally 4 weeks at 8/week. Module production would be complete by 3/19/05. At this point there are one assembly technician and one bonding technician trained. There was no plan for training of additional personnel prior to the start of production.
- Module production is a 4-day process. There is currently tooling available for processing two modules in parallel. After the second day, the tooling for the initial production steps is available for starting a second pair of modules. This allows for assembly of 4 modules per week. Some additional tooling has been identified to facilitate the production.
- The plan for quality assurance and testing of modules as presented is consistent with what was done for previous projects. The R&D effort with respect to the grounding/shielding scheme has been successful but the production testing plan does not include a specific test to ensure the appropriate functionality of the implementation derived from such R&D.
- The schedule presented to the committee indicated that the support structure and tooling would not be ready for module installation until February 2005.
- The 2005 shutdown is scheduled for 8/8/05. The start date and duration are likely to be driven by the CDF and D0 detectors. The committee was informed that the Tevatron group may wish to delay the start date to allow more operations time with electron cooling before the shutdown.

Recommendations

- We recommend that the project reduce the number of hybrids per shipment both from NXGen to Fresno and between Fresno and FNAL so that single-shipment loss cannot jeopardize the project as a whole. We also urge the project to

consider sending someone to NXGen while the final batch of hybrids is fabricated, as has been done for all the prototype and preproduction runs.

- We feel it is imperative that the additional tooling identified to facilitate the production (sensor Kapton wrapping fixture, sensor/flex/hybrid alignment and bonding tools) should be fast-tracked so that additional pre-production parts can be fabricated with this tooling prior to the start of production. These parts could also be used for training of additional personnel for assembly and bonding which will be necessary if the project decides to move to 8 module/week production rate. We recommend that D0 follow their plan to fabricate additional tooling that would allow for up to 8 modules to be produced per week. ***One of the sets of tooling should be designed to accommodate the out-of-tolerance hybrids.***
- Wire bond protection (bumpers or encapsulation) should be included as a part of module production. We recommend that this work be done prior to the final tests that will be used to grade the modules. This is a critical operation that could damage wire bonds. The additional adhesive on the active sensor surface could affect final noise performance of the sensor modules as well.
- We recommend burn-in be performed at the maximum anticipated operating voltage of 300V. A system should be implement to ensure the integrity of the burn-in and testing data, i.e. that the critical data is backed up daily.
- We believe that the project should consider placing an order for 50 of the second pitch adapter type from ATT. If these are of higher quality (consistent high bond pull strength) and are available, they should be used in place of the pitch adapters from TFT Seigert.
- We suggest that the project consider employing independent personnel for visual inspection at each stage of production, i.e. that people are not inspecting their own work. The concern is that people tend to concentrate on areas where they had difficulties and may gloss over other regions in their inspections.
- We recommend that the project consider development and implementation of a new test in order to certify the effectiveness of the grounding/shielding scheme. A parameter to be monitored is the noise induced occupancy while running the SVX4 ASICS with the nominal operating conditions (sparse mode with the nominal thresholds). Such occupancy can strongly degrade the performance of the modules if above a certain value by inducing additional read-out time. This parameter should be closely monitored while installing the modules on the carbon fiber support structure so that *in-situ* corrections and or improvements can be applied.
- We recommend that any systematic effects, no matter how minor, be thoroughly investigated. It is our opinion that this should be a higher priority than increasing the production rate. We further suggest testing with faster rise time to increase significance (magnification of noise).